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On globalisation, trade and wages

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Abstract:

Low skilled workers have been facing declining real wages during the 80s in the US, while high skilled workers gained in the same period. This decrease in the relative wage of the low skilled provoked a lively debate on the causes of the observed decline. A lot of academic authors have opposed to the popular view that trade with low wage countries caused the relative deterioration of low skilled workers.

This paper addresses the central question, whether we can ignore the role for trade on the basis of existing literature. To answer this question, we first set forth basic trade theory. Next the theoretical basis for empirical validation is established, whereafter the empirical contributions of several authors are reviewed. Finally alternative explanations are assessed. On the basis of this survey we argue that the denial of a role for trade by a number of contributors to the debate is not convincing.

1. Introduction.¹

Declining real wages by 11 % in the US in the 80s! Are we living in an age of diminishing prosperity? The decline in real wages is not just experienced by a small fraction of all workers. Less skilled workers have actually been facing declining wages for a long period. While high skilled workers experienced increasing real wages. The fact that this decline in the relative wage of less skilled workers was paralleled by an increase of the relative skill level of the working force is somewhat counter-intuitive, or at least cries for an explanation.

The populist press connected the rise in inequality in the 80s immediately with trade with low wage countries. Obvious explanations are not always correct explanations, hence some academic economists gave a counter reaction in the sense that some of them argued that the role for

¹ Most of the work on this paper has been carried out while I was working at the CPB, The Netherlands Bureau for Economic Policy Analysis. Discussions with and comments of Theo van de Klundert, Paul Tang, André de Jong and Henri de Groot have contributed to the paper.

foreign trade in this matter is negligible. By doing so, they initiated a lively debate on the cause of the observed decrease of the relative wage of low skilled workers.

This paper reviews the literature dealing with the question: "What caused the decrease in the relative wage of low-skilled workers in the US in the 80s?" The question implies that the paper focuses on empirical results.

The remainder of the paper is organised along the following lines. The next section more elaborately discusses the fact that instigated the debate. Section 3 analyses the question in a simple supply and demand framework. As is obvious, as the relative wage *and* the relative supply of high skilled workers increased in the 80s, the basic question deals with the demand side. Section 4 deals with the analysis of changes in the relative demand for skilled labour in relation with trade. This section's framework is the classroom version of the Heckscher-Ohlin model of trade. Confusing and disappointing results lead many authors to point at biased technological change to explain the changes in relative demand for skilled workers. Section 5 deals with theory and econometric results related to the biased technological change explanation. The modest performance of the classroom trade model directed others to research with a deviating or more extended trade model as basis. Section 6 reviews their work. Section 7 presents some deviating approaches; the approaches that not have been scrutinized empirically. Section 8 weights out all approaches. Section 9 summarizes and concludes.

2. Documenting the facts

We first document the facts and postpone the discussion of potential causes. A few prominent trends characterised the US labour market in the 70s and 80s. The first is a stagnant development of average real wages. Until '73 real wages rose rapidly, in the period from '63 to '73 an increase of 25%! In the period from '73 to '89, real wages were roughly constant (Murphy and Welch, 1992). The second development is that *within* narrowly defined groups on the labour market inequality increased.² The third is that in clear contrast with the 70s, the earnings differential between groups with high and low levels of education increased (see Table I). The fourth

trend is that educational attainment rose over the 80s (see Table II). Combining the second and third trend we could, reasonably, formulate a fifth trend: overall inequality increases tremendously. For a more extensive overview of labour market trends in the 80s is referred to Kosters (1994).

We primarily focus on the increased wage inequality between groups with different educational attainment in the 80s. Empirical analysis of the earnings inequality produced a bulk of literature. We restrict ourselves to the more recent contributions. For a comprehensive survey of the pre-90s work, the reader is referred to Levy and Murnane (1992).

Similar changes in education premiums and educational attainment as those described above for the US are found in other countries. Table I shows education wage premiums for several countries; depicted are the five year average changes in the earnings ratio of college versus high school educated. A quick glance at the table shows similar changes in most countries, with the Netherlands and Japan as notable exceptions. Table II reveals that supply changes in other countries followed a similar pattern.

In the remainder of the paper we try to figure out what the explanations are for the facts presented above. Related facts and other trends that might be a clue are the following. (1) The return to experience rose substantially in the 80s. Thus, this alternative indicator human capital was also rewarded higher (Kosters, 1994). (2) The manufacturing sector shrank substantially. The share of manufacturing employment has fallen from 26% to 18% between 1971 and 1990. This trend is a common phenomenon in all industrial countries. (3) The gender wage gap declined. (4) Productivity growth slowed down for most of the OECD countries in the early seventies. The consequence of the slow down is of course a more modest development of real earnings. (5) Growth in trade was enormous in the 70s and slowed down in the 80s.

3. Supply, Demand and Institutions³

A simple framework will be applied for analyzing the complex question on the causes of the observed relative wage change. We analyze demand and supply for labour and the institutional settings on the labour market. Here a broad definition of demand shifts is taken. The essential distinction between shifts *of* and *along* the demand curve will be made later on.

Murphy and Welch (1992)⁴ focus on relative supply changes and test whether this, in combination with a constant demand structure, fits the facts. What they basically apply is a simple supply and demand framework wherein workers are differentiated by age and education. First they examine the assumption of a stable labour demand structure. For all groups, supply changes should be reflected in opposite wage changes. For the 1963-1979 interval this expectation seems confirmed. The decreasing college premium in the 70s is matched by a relatively strong increase in average educational attainment. For the period after that ('80-89) the results indicate that a strong demand shift has been accompanying the slowing supply increases of educated workers.

The next step is to assess the nature of the demand shift for this latter period. A stable trend rate in demand change is consistent with the facts. An interpretation where the demand shift is related to unemployment shifts⁵ together with trade penetration is neither rejected.⁶ To sum up: demographics (or stated differently, supply changes of educated relative to less educated workers) are important. But to clarify the complete picture, demand changes should be examined. This result is obvious if we depict the relative supply change and the relative wage change as in figure 1 (Bound and Johnson, 1992). Moving from 1980 to 1990 for example and depicting the increase in relative supply and the change in the relative wage (ns shifts to ns'), one immediately sees that somehow a relative demand change is needed to attain the observed wage level (w''), for example a shift to the dashed line (nd').

As supply shifts cannot bear the sole responsibility for the observed trend, a first step in detecting demand shift causes, is made by Katz and Murphy (1992).⁷ They attempt to connect jobs with industries. In their analysis Katz and Murphy distinguish *within* industry and *between* industry demand shifts. Within industry shifts are shifts changing relative factor intensities at

fixed relative factor prices; these are related to changing non-labour input prices⁸ and non-neutral factor productivity change for example. Between industry shifts are those that change the allocation of total labour between industries at fixed relative factor prices and are connected with demand shifts (trade induced⁹) or differences between industries in factor productivity growth. Again, besides supply changes, demand changes in favour of the college educated workers are necessary to fit the facts (whether a stable demand trend does the job depends on the assumed substitution elasticity between college and high school graduates). This (nearly) stable demand shift masks however the fact that for college graduates the between industry shift in demand slowed down in the 80s while the within shifts accelerated from 1967 to 1987.

In our supply-demand-institutions framework several other potential explanations are to be considered. In the following we briefly review explanations that are not extensively discussed in the literature.

As we have seen, *measured* labour supply shifts could only partially contribute to the explanation of the observed trends. It is possible though that *unmeasured* supply changes are important. The inflow of illegal immigrants is one of these unregistered supply changes (this inflow is probably an unmeasured increase in low skilled labour). Leamer (1994) and Bound and Johnson (1992), among others, suggests this explanation. It is beyond the scope of this paper to deal extensively with this issue, see for example the book edited by Borjas and Freeman (1992).¹⁰ Alternatively, a decline in educational quality of the low skilled workers is also an implicit supply change (that would also result in an increase in the education premium).¹¹ Opinions about the importance of these unmeasured supply changes are rather diverse.

We have already stated that demand changes, besides supply changes, are an important part of the explanation. The only, not yet discussed, element of the framework is the institutional environment. Here several changes occurred that might have been relevant. First, declining unionisation is observed. Bound and Johnson (1992) test directly for the influence of unionisation and indirectly via the importance of rents and conclude that deunionisation does not explain a very large part of the relative wage change. Second, decreasing relevance of the minimum wage might play a role; only a small proportion of the work force can be affected by this institutional change and besides the increased wage dispersion is also caused by changes in

the upper part of the wage distribution. Third, deregulation; this might have affected wage setting behaviour.¹² You can think of a lot more government measures, like changes in the social security system, that might have affected the wage structure somehow.

For several reasons we do not explore these (potentially not irrelevant) institutional changes further: (i) the ones that are documented in the literature have played a minor role, (ii) there is no reason to assume that these measures did coincide internationally, as is required and (iii), we cannot tackle issues here that are not addressed in the literature.

The results reported above do obviously not provide a comprehensive explanation for the observed changes, they only point out that demand changes are necessary to provide an explanation. Thus we need to explore possible explanations for the demand shift.

4. Trade: an evaluation on the basis of the 2 x 2 x 2 Heckscher-Ohlin model

The observed increase in the gap between the factor rewards for high and low skilled workers, together with the more pronounced presence of low wage countries in the global economy, lead many observers to conclude that the latter caused the former. The argument that global market integration led to the increase in the wage gap, is fairly persuasive for many people. Economists have also been sympathetic to the argument, as there is there is a theorem in international trade theory, named after W. Stolper and P. Samuelson, that establishes a clear relation between global markets and internal factor rewards. The concept is clear; but the relevance of this concept for the issue at hand is strongly contradicted by several authors. In this section the logic of the Stolper-Samuelson theorem is set forth, whereafter several tests of the relevance of the Stolper-Samuelson theorem are reviewed.

Theory: the 2 x 2 x 2 Heckscher-Ohlin model¹³

Stolper and Samuelson (1941) established one of the theorems in the endowments based international trade theory connected with the names of Heckscher and Ohlin. To illustrate the logic of their theorem¹⁴ we will run through an example based on the situation in the US.

Suppose the U.S. is skilled labour abundant. Furthermore we assume that the US starts trading with LDCs due to a decline in trade barriers erected by the LDC. The US will shift production towards the skilled-intensive goods industries (the relative price of the skilled-intensive good is increased). As the shrinking sector is unskilled-intensive it releases relatively plentiful unskilled workers. Thus, the relative wage of the unskilled has to decline in order to get most of the unskilled absorbed in the skilled-intensive industry. This relative factor reward change also induces changes in the factor input ratio in the unskilled-intensive industry. Summarizing the results after the market has settled at the new equilibrium:

- (1) unskilled labour in the US will be harmed relatively and absolutely,
- (2) the ratio of skilled to unskilled in the US declines in both industries,
- (3) employment is shifted towards the skilled-intensive industry in the US,
- (4) the US exports the skilled-intensive good,
- (5) the price of the skilled-intensive good rises relative to the unskilled-intensive good and,
- (6) for the LDC, implication (1) to (5) are reversed.

Implication (1) is the basic observation that lead to the Stolper-Samuelson theorem.¹⁵ In the remainder of this section literature that directly or indirectly analyzes prediction (2) to (6) is reviewed.

The ratio of skilled to unskilled workers declines

Within all industries in the US the ratio of skilled to unskilled workers should decline. The method to examine this is the following. First, one needs to distinguish skilled and unskilled workers in the labour force. Secondly, the relative wage increase of skilled workers should be met with a decrease in the relative employment of the skilled workers.

Krugman and Lawrence (1993) perform some analysis on this implication. Skilled versus unskilled workers are approximated by blue-collar and white-collar workers. The change in the ratio between these blue- and white-collar workers is analyzed for the manufacturing sector.¹⁶ The manufacturing sector is decomposed in industries at the 2-digit SIC level. Opposite to the

prediction, Krugman *et. al.* find for nearly all of the observation an increase in the ratio of skilled to unskilled workers within industries.

Lawrence and Slaughter (1993) perform a similar test. They distinguish skilled and unskilled workers by respectively non-production and production workers. At 2,3 and 4 digit industry level they find that the ratio of skilled to unskilled workers increases; again opposite to the theoretical prediction! Their conclusion is that the Stolper-Samuelson effect is (at least) overwhelmed by something else.

With respect to this test of the Stolper-Samuelson theorem¹⁷ there are two vital theoretical limitations. The first *basic* issue is the fact that the logic of the Stolper-Samuelson prediction of an increase in the ratio of low to high skilled workers holds only in the case of unchanged endowments. Three influences that might violate this condition are the following. The shrinkage of the overall size of the manufacturing sector should be taken into account. The relative supply of high skilled workers increased substantially during the 80s.¹⁸ Changes in unemployment might also affect 'endowments'. That the Rybczynski theorem learns that factor intensities are unaffected by factor endowment changes, is only relevant for small countries.

A decreasing size of the manufacturing sector provides the connection with the second *basic* issue why the increase in skill intensity is a disputable basis for rejecting the role for trade. In the section 6 we will stress more extensively the following: the assumption of homogenous and unchanging production functions within industries and equal production techniques across borders is unrealistic and disturbing if you want to explore the role of trade. We want to distinguish more activities within one singly statistical industry, but more on this later.

Besides the theoretical limitations, there is a serious empirical limitation. This limitation concerns the appropriateness of the production/non-production workers division to approximate unskilled and skilled workers. Leamer (1994) stresses clearly that this approximation is troublesome. Workers occupied with product development are for example classified as production workers, whereas workers performing routine office functions and those delivering sales are categorized in the non-production worker category. Similar problems exist with the blue/white-collar distinction.¹⁹

Employment shifts towards the skilled-intensive industries

An employment shift toward the skilled-intensive industries should be accompanying the relative wage trend if the Stolper-Samuelson theorem tells the true story. A test for this prediction is simple: order industries by skill intensity and analyze whether the employment growth is most pronounced for the skilled-intensive industries.

Krugman and Lawrence (1993) are, to our awareness, the only authors who tested this prediction. Depicting the relative skill intensity in 1979 together with the growth in employment between '79 and '89 for the industries they distinguish, learns that the skill intensive industries showed no tendency to grow faster.

The limitations are essentially similar to those that apply to the first test. Theoretically, we will argue, that more activities should be distinguished within industries (or, equivalently, that the level of disaggregation is too limited). Therefore, denoting the skill intensity of an industry, consisting of a rather broad set of production activities, in a single number is precarious.

The previous remark might also be interpreted as an empirical limitation, but besides this one, the used identification of a worker's skill level remains of course uncomfortable.

The US exports the skilled-intensive good and imports the unskilled-intensive good

Economist, who have heard of the Stolper-Samuelson theorem, but do not know the rights of it have, uselessly, tried to estimate or assess the impact of trade on the domestic economy using the volume of trade as an indicator. This opinion is most forcefully expressed by Leamer (1994, 1995, 1996b). It is probably the prediction that US imports the unskilled-intensive good that induces factor content of trade calculations.

The argument for the use of the so called Factor Content of Trade (FCT) calculations is appealing; you estimate what *would* have been the demand for factors of production *had* the domestic economy been isolated from world trade. The factor content of trade methodology is rather familiar, and therefore the explanation -- based on Wood (1994) -- will be brief.

$$z_{x,VS} = A_{VS} x_{VS} \quad z_{m,VS} = A_{VS} x_{LDC}$$

Where x_{US} is the vector of sectoral shares of the manufacturing exports, A_{US} is the factor use matrix and thus $z_{x,US}$ is the factor content coefficient for exports. A similar vector can be calculated for imports ($z_{m,US}$). If we now assume that US exports are balanced with LDC exports, we are able to calculate the change in factor demand had the US produced the goods themselves.

$$Z_{VS} = X_{LDC} (z_{x,VS} - z_{m,VS})$$

Where X_{LDC} is the vector of net import values.

Katz and Murphy (1992), discussed in section 3, also did some analysis of the underlying causes of the increased education premium and found some role for trade. Katz and Murphy estimated the impact of trade, using the FCT method and found that the direction of the trade induced shifts was consistent with the observed pattern, but that the magnitude was (too) small.²⁰

Sachs and Shatz (1994) vary slightly on the FCT approach by calculating²¹ counterfactual employment shares. Via an input-output matrix final demand for a sector is estimated for 1990 keeping the import penetration quote at the level of 1978. Being aware that this is a serious shortcut, the counterfactual output levels are *directly* translated in factor demand. Next they order industries by skill intensity and identify the relevant trade partners for these industries (DC or LDC). They find that less skilled-intensive sectors are hit relatively hard and that the resulting demand shift of 5.1% toward non-production workers is foremost caused by trade with LDCs. More than concluding that a tendency towards increased wage differentials might arise from this employment shift, is not possible.

FCT calculations are based on the magnitude or volume of trade, some authors use the volume of trade directly to underpin their arguments.

Krugman and Lawrence's (1993) final argument, to support their conclusion that it is implausible that trade played a substantial role in widening the wage gap, fits also in this section. Krugman *et. al.* argue, first, that the bulk of US trade is with high wage countries and

second, that trade in the US is still a small fraction of output. In later work Lawrence (1994) reiterates this as follows: "US imports from developing countries did increase rapidly over the decade, but again what needs to be born in mind is the magnitude." (p.13). Thus their argument is basically that the magnitude of trade with low-wage countries is simply too small to affect wages substantially.

Murphy and Welch (1992) also proxied the impact of trade by a volume indicator: the net import of durables as a share of GNP. Trade, is found to be a significant determinant of wages. Murphy and Welch state explicitly that they are not convinced that trade is the ultimate cause for the observed changes; biased technological progress might also be relevant.²²

The limitations of the factor content of trade approach have led to a heated debate in itself. Leamer condemned work based on FCT as: "incompetent, immaterial and irrelevant" where Krugman (1995) called FCT: "a procedure that turns out to be entirely reasonable." (p.38)

Leamer's (1994, 1995, 1996b) critical argument runs as follows. The Stolper-Samuelson theorem connects factor rewards with goods prices via zero profit conditions, without the volume of trade entering the formulation of the theorem. To clarify: suppose a country faces increased competition in low skilled-intensive goods, but that it succeeds to keep a constant market share by lowering the wages of low skilled employees. When you examine whether trade can be blamed, you won't see any change in the FCT, so the answer will be no. This is obviously the wrong conclusion, hence ex-post trade volumes are an unreliable indicator of the ex-ante threat.²³ To restate the argument brief: factor prices are set on the margin.

In a clarifying paper, Deardorf and Staiger (1988) show that the translation from FCT to domestic factor prices is indeed not as obvious as it seems. By constructing an 'equivalent autarky equilibrium', *i.e.* adjusting domestic resources for the amount that is contented in trade, they are only able to exclude the counter-intuitive result, that factor prices move along with endowments, under fairly restrictive assumptions (unitary substitution elasticity on the demand and production side). Leamer (1996b) reiterates and extends the analysis by Deardorf and Staiger and adds to their conclusions that only the repercussions for earning *shares* (not levels) of a complete elimination of trade can be established under the mentioned restrictive assumptions. More intuitively: the problem is that factors embodied in trade are determined simulta-

neously by tastes, technologies, factor supplies, external goods markets and the deficit/surplus on the trade balance.²⁴ Without being exhaustive, Leamer (1996b), Bhagwati and Dehejia (1994), Sachs and Shatz (1994) and Lawrence and Slaughter (1993) conclude that it is the development in goods prices that should be analyzed.²⁵

Krugman (1995) calls the FCT calculations an "entirely reasonable" exercise, with the restriction that trade deficits should be handled with care. How is this radically different view possible? First of all Krugman is eager to accept the restrictions following from the Deardorf and Staiger analysis as being not too far from realistic. The second and more *fundamental* difference is Krugman's rejection of the argument that prices can be treated as exogenous. Throughout the debate this issue causes a watershed. The proponents of the price approach see a country as price taker, the others see relative world market prices as endogenous. Krugman's (1995) argument runs as follows. First, he asserts that the US, let alone the whole OECD, will alter goods prices if technology or factor supplies are changed. Thus, the price approach is incapable of disentangling domestic and foreign causes. As we want to know, what wages would have been, had *only* the trade from low wage countries been impossible, the volume of trade is a crucial piece of evidence.²⁶

So we are left with two compelling arguments favouring two different approaches. The verdict on the appropriate methodology (and with it the use of FCT) depends on the belief whether or not prices can be treated as exogenous. Whatever the verdict however, one empirical problem remains and that is how to treat the trade deficit.

Next the results based on the price approach are reviewed.

The relative price of the unskilled-intensive good declines

The price of the low skilled-intensive good declines, this is translated via the zero profit conditions in factor rewards. A lower relative factor reward for the low skilled in the relative low skilled scarce country results. This is a reliable indicator, as it is the beginning of the chain of causation.²⁷ To apply this correct you have to adjust for difference in Hicks-neutral technological change between trade partners.

In search for the answer whether or not foreign competition plays a role, Lawrence and Slaughter (1993), put their finger where one should put it: at the beginning of the causation. They test whether prices of unskilled-intensive goods declined relative to skilled-intensive goods. This appears not to be the case, they find the opposite. No more is necessary to show that trade is not the important cause for the observed increase in wage inequality. Baldwin and Cain use a similar approach to double-check their other findings (reported on later) and find a similar pattern as Lawrence and Slaughter.

Sachs and Shatz (1994) also look at the for the Stolper-Samuelson theorem relevant relative price changes. Opposite to Lawrence and Slaughter, the view that the Stolper-Samuelson mechanism was at work is supported! The notion that in the calculations in both papers the production / non-production worker ratio is used, leaves differences in the data as the obvious explanation for the opposite result. Sachs and Shatz indeed point at the different use of data. They add a dummy for computers. This is essential for their result.²⁸ They admit that what they find is not enough to explain the huge increase in earnings inequality and point at the interaction between asymmetric technological development and the lowering of low skilled-intensive goods prices.

Leamer (1996a) performs a somewhat different exercise over a more extended period, namely from 1970 to 1990. Leamer starts with "the fundamental condition linking product price changes, factor cost changes and technology changes" (p. 23):

$$\hat{p} = \theta \hat{w} - T\hat{F}P$$

and tries to disentangle the part of factor price changes that is due to technological change and the part that is due to globalisation (θ are factor shares). This equation should be interpreted as telling that goods price changes lead to factor price changes and that productivity increases lead to factor price increases *if* prices are fully determined on the world market. The theory however says nothing about the relation between total factor productivity (TFP) and price changes. An assumption on how much of the productivity gain is passed on to lower price should be made to be able to calculate the technological effect on wages. Leamer takes two extremes: full pass-through and no pass through. If the sector-specific TFP_i change is fully passed on into lower

prices, there is no room for (sector) biased technological change to affect factor rewards (the only technology effect on factor rewards is the average TFP change). Given the pass-through assumption λ the wage change attributable to technological change is:

$$(1 - \lambda)\hat{TFP} = \theta_i \hat{w}_{tech}$$

The remainder²⁹ is due to globalisation:

$$\hat{p} + \lambda \hat{TFP} = \theta \hat{w}_{glob}$$

The regression analysis is based on the latter two equations. The left hand side -- sectoral TFP growth and sectoral inflation corrected for TFP induced changes -- is the dependent variable. Whereas the (beginning of the period) factor shares are the independent variables. The estimated coefficients are mandated factor price changes, *i.e.* changes that are consistent with no changes in profits. In the 60s the price/globalisation effect worked strongly against capital but the technology effect compensated fully. In the 70s the globalisation effect worked strongly against low wage workers and the technology effect worked weakly against the low wage workers. In the 80s the globalisation effect works out strongly against capital and is favouring high and low wage labour, where technology affects high wage workers unfavourably.

Thus the 70s is period where the action is with respect to globalisation. Two remarks need to be made. First, the early pinpoint of the globalisation effect driving down the rewards for low wage workers, is at first instance explained by pointing at lags in spreading this effect in the economy but secondly Leamer argues strongly against situating the wage gap increase in the 80s. Why? The non-production versus production worker division is inaccurate. Criticising these groups implies that Leamer has to come up with an alternative division. High- and low-wage workers are constructed by marking the highest paying industry as high-wage (high-skill??) and assuming that only high wage workers are employed in that sector and the same for the lowest paying industry. The ratio of high- and low wage workers in all other sectors is constructed by linear intrapolation.

Krueger (1997) devotes a whole paper to the what he calls the "price puzzle". Using a new dataset, the relation between skill intensity and price development is estimated once more. The advantages of the Krueger data³⁰ are a 4 digit level of aggregation and a more recent period (1989-1995). Krueger convincingly reconfirms what Sachs and Shatz (1994) find: a positive

relation between skill intensity and price growth that is robust for several indicators for skill intensity.

A theoretical limitation in (early) work on relative prices is pointed at by Davis and Topel in commenting the work of Lawrence and Slaughter (1993) on the relative prices: "Once technical change is accepted as a major driving force behind relative wage movements, relative price movements for traded goods no longer provide an accurate indicator of the direction or magnitude of trade's effect on relative wages." (p. 220) This comment cuts ice, as Lawrence and Slaughter in their analysis of sector bias in technological change assume given prices. Thus implicitly is assumed that technological change is a local phenomenon. Krueger (1997) does not use TFP data to correct relative price changes either. He argues that TFP changes will harmlessly add to the error term if TFP growth is uncorrelated with the other variables explaining price growth. Sachs and Shatz (1994) and Leamer (1996a) on the other hand adjusted their prices for TFP changes before assessing the Stolper-Samuelson price changes. A limitation to Leamer's work is that smooth functioning markets are assumed throughout the analysis.

A clear empirical limitation of the test for this Heckscher-Ohlin prediction is that measuring trade prices is notoriously difficult. For example, because of changes in the product mix and quality of the goods. Correcting for TFP changes is an exercise that is known to be inherently problematic also. Therefore you might not be surprised that we end up with conflicting results in different papers.

For the low skilled abundant trade partners the predictions are inverted.

As is assumed, formerly erected trade barriers between LDCs and the US are considerably reduced. The Heckscher-Ohlin model predicts for the low skilled abundant LDC exactly the opposite movements in production and prices to what is predicted for the US. As studies for the low skilled abundant regions are scarce and data availability is limited the summary of results is restricted to the prediction for factor rewards. The gap between low skilled and high skilled worker wages should decline.

Wood (1994) finds for Southern Countries a reduction in the wage inequality, as predicted by the Heckscher-Ohlin theory. As Wood distinguishes three types of labour, the prediction of declining overall inequality is not obvious. Lowering trade barriers, causes the South to specialise towards basic-educated-intensive goods. The wage differential between high skilled and those with basic education should decline, but the differential between the average high skilled/basic educated and those without education should widen. Thus the prediction with respect to overall inequality is not unambiguous, but Wood expects a decline in inequality and finds it.

A cross-country regression of inequality and export share in manufacturing yields a significant negative sign, but it is probably not too hard to convince anyone that this is not very informative. Time series analyses yields again the expected sign but the results are hardly significant. Besides, in such a time series analysis you should account for supply changes to be able to distil a role for trade with the North.

Next the changes in Mexican (and Moroccan³¹) relative wages are discussed. Why should we discuss Mexico separately? First, the Mexican changes in the 80s have some resemblance to a laboratory experiment.³² Second, the Mexican economy is well documented in the literature. Major changes were: a considerable liberalisation of trade and Mexico announced to join the GATT. Hanson and Harrison (1995) test whether observed changes in relative wages fit in the Heckscher-Ohlin framework. As the US is Mexico's most important trade partner³³ and the US is relatively skilled labour rich, the Heckscher-Ohlin prediction is a declining inequality between skilled and unskilled workers in Mexico. The reality differs though. Between 1984 and 1990 the relative wage of the skilled rose substantially, with 33%! Hanson and Harrison took this as a starting point to make-up stories³⁴ that were consistent with Heckscher-Ohlin predictions *and* the observed wage inequality pattern. After testing for the implications of these stories is concluded that there is no way that the facts can be reconciled with the Heckscher-Ohlin theory.

Even the ones who are sympathetic to the explanation that the increase in the wage gap is due to non-domestic factors, *i.e.* trade, have to admit that the evidence with respect to the 2 x 2 x 2 Heckscher-Ohlin model is at least mixed. The ratio of skilled to unskilled workers increases

instead of decreases at all levels of disaggregation that have been taken under consideration. Employment did not shift clearly in the direction of skilled-intensive industries. If you accept the FCT calculations as valid and informative, the magnitude of Heckscher-Ohlin tendencies is too small. The evolution of relative prices is the most direct measure of the Stolper-Samuelson effect, as it is the beginning of the chain of causation. The evidence, however, is mixed. Finally, the relative wage change in Mexico and Morocco is clearly opposite to the direction predicted by the Heckscher-Ohlin model. In relation to this latter piece of evidence one might wonder whether these are anomalies or representatives of a larger group?

Thus, irrespective of the discussions on the suitable approach and of the limitations on some tests of the Stolper-Samuelson predictions it is fair to state that the evidence is mixed. To formulate briefly what is at stake we use the evidence that *is* clear so far, to formulate the 'trade and wage puzzle': "The relative wage increase of skilled workers is accompanied by an increase in the ratio of skilled to unskilled workers within industries."

How to plow ahead given these findings? The fact that the predictions belonging to the $2 \times 2 \times 2$ Heckscher-Ohlin model are not confirmed lead basically to two approaches. One approach is to look for domestic causes, as the above reported evidence suggests that non-domestic causes are unlikely to be important. The domestic cause, some form of biased technological change, is subject of the next section. The other approach is not to reject a role for trade, but to refine or reformulate the Heckscher-Ohlin model, section 7 deals with this.

5. Biased technological change: an evaluation of domestic causes

The, at best, weak support for the trade related explanation lead authors to the alternative explanation of biased technological change. The logic is simple: the relative supply changes did not contribute much, clear evidence for a change in demand due to trade is not found, thus there is left a residual that can only be attributed to technological change. This explanation of biased technological change is prompted by the common sense idea that new technology mostly replaces unskilled workers; *e.g.* one worker operates the robot-system that replaced several

assembly line workers. This would, however, imply that the productivity of the unskilled workers goes up, and this should lower their wages???. It is time to sort out what type of technological change solves the 'trade and wage puzzle'.

Theory: the 2 x 2 model

To analyze what is meant by biased or asymmetric technological progress, again the two sector, two factor model is used. The necessity to distinguish two countries, like in the explanation of the trade related arguments, is not clear beforehand.

As there are many casus positions, we refer to Table III. This table is set up with a CES production function in mind with two factors of production, skilled and unskilled workers. The subscripts h and l indicate respectively variables for high and low skilled-intensive sectors.³⁵

Some cases are discussed extensively in the following, the others in Table III are merely for reference. First, the case of factor bias in the open economy. In Case A unskilled workers' productivity rises in both sectors, leaving world market prices unaffected. The repercussion of the increased productivity of unskilled workers is a wage change that is beneficial for low skilled workers. The intuition: the saving in labour costs is relatively strongest in the low-skilled sector. To restore equilibrium at world market prices the wage for the unskilled should increase most. Thus the productivity of the skilled, instead of the unskilled should rise to cause the increased wage inequality. In that case however (C), the skill intensity within sectors decreases. Hence the 'trade and wage puzzle' is not solved, unless we assume an accompanying change in the world market prices (E).³⁶

Second, the case of factor bias in the closed economy. This is the case where is assumed that technological change is a global phenomenon or that the changing technology alters world-prices (Krugman, 1995b). It is analyzed as if the world functions as a closed economy. Case B assumes unskilled labour saving technology, as in case A, but now the economy is closed. Take the empirically relevant circumstance where the substitution between skilled and unskilled workers is easy ($\sigma > 1$). A productivity gain is equivalent with saving unskilled workers, this causes relative abundance. The increased productivity tends to increases wages of the unskilled, whereas the relative abundance provides countervailing power. The downward pressure due to

relative abundance is weaker if the reallocation of workers in the production process is easy, *i.e.*, the higher the substitutability. If the substitution elasticity exceeds one, the productivity gain outweighs the abundance effect and a relative wage increase for low skilled workers results. The reallocation of the superfluous low-skilled workers takes care of the decrease in the skill intensity within industries. The results in Case B are opposite to the ones required to solve the 'trade and wage puzzle'. Therefore if technology increases the productivity of the high skilled instead of the low skilled (and the economy is closed) the predictions are in line with our 'puzzle'.

Third, the case of sector bias in the open economy. Hence, we discuss intersectoral differences in the pace of Hicks neutral technological progress. In case of given prices (Case F & H), a Hicks neutral technological improvement means that a firm can afford to pay more for its factors to maintain zero profits. Therefore the relative wage of the factor used intensively in the sector experiencing a higher level of efficiency increases. (Mussa, 1979 or Bhagwati and Srinivasan (1983) Chapter 5).

Finally, the case of sector bias in the closed economy. For the closed economy case (I) we can no longer avoid taking the demand side into account. In case the low skilled-intensive sector experiences a Hicks neutral productivity increase and demand is inelastic, low skilled workers are harmed.³⁷

Thus, skilled instead of unskilled labour saving technology is the principle cause. This is easily seen when it is recognized that unskilled labour saving technology is the equivalent of increasing productivity of the unskilled. The 'trade and wage puzzle' (the combination of increased relative wages for skilled workers with the increased skill intensity of production) is 'solved' by biased technological change in two ways. One possibility, in the closed economy, high skilled biased technological improvement in combination with ample substitution possibilities yields this result. The second is the combination of two shocks on the small open economy: unskilled factor biased technological improvement together with a decrease in the relative price of unskilled-intensive goods.

Theory: Endogenous technological change

We are looking for the basic behavioral assumptions or structural changes that caused an increased skill premium. The following notions are preliminary and there is hardly any evidence supporting nor rejecting these speculations.

That necessity is the mother of invention is something hardly disputable after a decennium of endogenous growth theory. If it would be asymmetric technological progress that drives the observed trend, what is the incentive for developing that technology?

First the incentives for generating a sector bias by endogenous technological change are considered. Two directions can be followed. The first is that increased competition lowers the future stream of profits and therefore the potential gains from investment in R&D. When we assume that competition increased mostly in unskilled-intensive sectors causing these sectors to perform less R&D, what ultimately causes a sluggish TFP development, this might lead to trade induced biased technological change. This is biased in the sense that it differs across industries, according to skill intensity (see table III, case F).

A second line of reasoning works in a similar direction, wages of skilled workers tend to rise relative to unskilled workers (caused³⁸ by trade??); as R&D activity is thought to be high-skilled-intensive the relative wage trend makes producing more attractive than innovating, at least in industries where production is low skilled-intensive. Therefore this mechanism might again work out asymmetric across industries, where again low skilled-intensive industries face lower incentives to innovate.³⁹ This is opposite to the common sense argument that increased competition would cause producers to economise, causing an increase in productivity (it is important in this respect not to confuse the static gain of reducing X-inefficiency with the dynamic aspect of efficiency increase, TFP growth).

Note that the above reasonings on endogenous technological both hinge on trade or at least are likely to be related to trade. It is hard to imagine an endogenous technological change mechanism that stands on it's own and that affects the unskilled unfavourably.

Evidence

A fair amount of "evidence" in favour of the 'biased technological change' explanation consists of rejections of trade related explanations. The approach of rejecting trade as an explanation and assigning the unexplained residual to technology is common practise. There are in principle no objections to a proper application of this strategy. The key word here is 'proper' however; a discussion on whether this strategy has been applied accurately is postponed. In this section *direct*⁴⁰ evidence for 'biased technological change' as an answer to our basic question will be reviewed.

Using micro data, Krueger (1993) provides direct evidence on the *type* of technological change that is relevant. Using CPS data for '84 and '89, the impact of the 'computer revolution' is assessed. As a take off some descriptive data: computer use increased with 50%, to 38% of the workers in the sample. The use increases strongly by educational attainment and the use is very widespread in sheltered industries as insurance, banking and public administration. In a Mincerian wage equation, a dummy for computers is added. In '84 the use of computers yields an additional pay-off of 18.5%, in '89 this is even slightly higher. Obvious checks⁴¹ do not alter the result.

One serious limitation, as always, remains: is it actually the use of computers that is valued by employers, or does the variable represent something else that is omitted in the regression?⁴² Taking the results for granted -- for a minute -- Krueger explains half of the increase in education premium, and even more when the interaction between computer use and education is taken into account. DiNardo and Pischke (1996) first replicate Kruegers result using a German dataset. Next, they show forcefully that computer use reflects some unobserved heterogeneity in the dataset. Sitting down while working and using pencils have alongside computer-use a significant effect on wages. DiNardo and Pischke exclude that this reflects the fact that workers have a (high paying) office job. These findings cast serious doubt on the interpretation of the computer-use premium as reflecting a productivity bias.

In view of the previous discussion on the theory, Krueger's work might lead us to accepting the view, opposite to the popular one, that it is indeed high skilled labour saving technology

that is relevant. But remind that in the open economy case the skill intensity within sectors moves in theory in the opposite direction from the one actually observed.

Simultaneously with suggesting that asymmetric technological progress is the plausible alternative for trade as an explanation for the observed trends, several authors refer to Bartel and Lichtenberg (1987) and Mincer (1991) for supporting evidence. Bartel and Lichtenberg did path breaking work on capital/technology - skill complementarity. They established a relation between skill composition of the workforce and the capital stock. Industries with newer capital or higher R&D intensity have a more educated workforce.

The capital/technology - skill complementarity, found in earlier cross-sectional studies, establishes no causal relation. Estimating this in a time series framework would be an improvement. Mincer (1991)⁴³ relates in a time-series approach the human capital profitability to the pace of technology correcting for other factors (as for example supply changes). R&D indices do rather well as a proxy for technology).⁴⁴

Berman, Bound and Griliches (1994) report findings for the manufacturing sector.⁴⁵ The question they want to answer is: What causes the increase in the fraction of non-production workers (or their part in the wage bill) in manufacturing? There is no clear underlying model they use.

Between '79 and '89, the number of production workers declined by 15% as the number of non-production workers increased by 3%. Between and within industry shifts are distinguished; the latter explains 1/3, the former the remaining part. Their first contribution is to subdivide the between and within shifts in end-use categories: exports minus imports, domestic consumption and defense.⁴⁶ Berman, Bound and Griliches conclude that trade cannot be a principal cause of the observed trends in wage bill. Biased technological change is offered as an alternative. Their second contribution is that they try to measure directly the importance of biased technological progress. A cross-sectional regression is used in the following manner. The annual change in the non-production workers' share in the wage bill is the dependent variable. Independent variables are time period dummies and the change in capital intensity. The data on other production factors allow to identify complementarities. A capital/skill complementarity,⁴⁷ suggested by Bartel and Lichtenberg (1987), is reconfirmed. Next, they add the importance of com-

puters and R&D expenditures over sales as independent variables. They attribute significantly to the explanation of the increase of non-production workers wage bill. Berman *et. al.* conclude that asymmetric technological progress is the major cause for the shift towards non-production workers; trade might have been a minor amplifying effect.

We encountered the work of Lawrence and Slaughter (1993) already in the assessment of the 2 x 2 x 2 Heckscher-Ohlin model. Having rejected this model technological change is left as an explanation. First, they test whether Hicks-neutral changes/differences in technology between industries are relevant. They assume given prices. Two predictions are to be tested (Table III, case F). The ratio of skilled over unskilled workers should fall. As we already know, it doesn't. A more direct prediction to test is the notion that total factor productivity growth should be most pronounced in skilled labour intensive industries. This sector bias in technological change is (not convincingly) found. For Lawrence and Slaughter, nothing else is left than to point at factor biased technological change as a possible explanation.

Leamer (1994, 1996a) comments⁴⁸ on methodology and presents also some preliminary empirical work. Leamer finds⁴⁹ (as reported in section 4) that technology clearly has decreased inequality!

In a promising approach, Baldwin and Cain assess the dominant factor causing relative wage changes. In the context of a general equilibrium model technological changes, relative endowment shifts and alterations in the trade pattern are simultaneously taken into account.⁵⁰ Exceptionally, they use a large open economy framework. Using various data sources they assess which of the three driving forces is consistent with the observed pattern in goods and factor prices, skill intensities and output changes. For the late 60s to the early 70s the relative supply increase of high skilled workers is important. For the 70s the relative supply increase together with an unfavourable bias against unskilled workers is the driving force. And for 80s is pointed again to biased technological change.

Baldwin and Cain are aware of the theoretical limitation that the approach is not capable to discriminate between all potential explanations. A second limitation of a theoretical nature is common in the work on this topic; the problematic distinction between high and low skilled workers. Baldwin and Cain, however, do not make a clear choice between a boundary at 11 or

12 years of education. They arbitrarily shift this boundary to provide the most convincing underpinning of their explanations.

Besides the usual limitations to econometric work there is a more principle problem. In the studies discussed in this section, industry data are used in regression equations to explain wage trends. The essential difficulty is that industries are treated as homogenous entities. It is hard to argue that industries are representing a single activity. What is meant is that industries consist of several activities and that activities can be distinguished and ordered by 'technology intensity' and skill intensity. Taking this conjecture for granted the above recited regressions are not as informative as they seem. Suppose that trade causes outsourcing or a shut down of the less skilled-intensive parts within industries. Likely the less skill-intensive parts are also 'technology extensive'. With the combination of these two assertions the conclusions connected to the regressions could also be a consequence of trade induced outsourcing.

The argument that highly disaggregated data are used cuts no ice. The fact that a 4 digit level disaggregation is not enough, is a problem that Berman *et. al.* recognize but surprisingly further ignore: "*Even within specific industries this "foreign outsourcing" is likely to have disproportionate effect on less skilled labour...*" (p. 376, italics added). More on this issue in section 6.

An exceptional approach is followed by Bound and Johnson (1992)⁵¹ when they evaluate alternative explanations for the changes in the structure of wages. Bound and Johnson try to answer the question on the causes of the observed changes in the wage structure, by estimating the contribution of alternative explanations in the context of a clear theoretical framework for the *closed* economy. In the framework there is allowed for some autonomous demand shift (caused by foreign competition or a preference shift). Criticizing this theoretical framework is easy,⁵² but it is their merit that the framework is clear and that all potential explanations fit in. Explanations are divided in (A) changes in the non-competitive part of wages (the rent) and the impact of workers changing between industries with different rents (see Krueger and Summers (1988)), and (B) in changes in the competitive part of wages. Where the latter is subdivided in changes caused by supply, demand, and technology. Demand shifts over 11 industries have a

modest (sometimes even wrongly directed) impact on relative wage changes. The change in factor specific technology contributes most importantly to the changes in relative wages; after accounting for this, hardly anything remains unexplained. This is not surprising, as they state: "The major difficulty with this explanation, unlike the explanations involving industry wage effects, supply and product demand, is (as in the analysis of the sources of economic growth) that it involves the residuals of the intrafactor demand function rather than directly observable phenomena" (p.383). Besides skilled-labour-biased technological change they think changing unmeasured labour quality is a principal reason for the increased wage differential.

6. Amending the trade model.

The weak performance of the basic trade model, reported on in section 4, guided research in two directions. The first is the direction of technological change favouring skilled workers. The rationale for pointing at biased technological change was that the other explanations did not contribute substantially to explain the observed wage trend. To speak with Leamer, their reasoning was: "Eliminate the impossible, and all that is left is truth" (1996a, p. 2). In this section we will argue that on the basis of the existing literature it has *not* been shown convincingly that "all the other" is eliminated. This induced a second strand of continuing research. In this section we will discuss extensively approaches related to international trade, but deviating from the basic 2x2x2 Heckscher-Ohlin model. The logic, that lacking evidence in favour of the basic trade model does not imply a negligible role for trade is blunt, but often 'forgotten'.

*Disaggregation, non-homogenous goods and outsourcing: a new assumption*⁵³

A fundamental change in the assumption behind the basic trade model is proposed in this section. The assumption that is altered in this section is that goods produced in one industry are homogenous. The hypothesis postulated here, is that it possible to distinguish more activities within a single industry. First, the rationale for this deviating hypothesis will be corroborated. Whereafter theoretical implementation of this assumption is shown, together with estimates for the impact of trade on wages.

To understand the rationale for the deviating assumption it is clarifying to take a closer look at industries. To set the stage, how do indigenous firms respond to increased competition for LDC firms? Probably by shedding their labour intensive parts (by outsourcing or leaving the business) and product upgrading (differentiation). Following an example makes the argument less abstract. Take the (4-digit!) television receivers industry.⁵⁴ The television receivers industry is taken as an example, as it is expositionally easy consider an industry where matters have settled.

It is first of all necessary to state that the television receivers industry in the sixties consisted of a few firms who made complete television sets, from plug to screen so to say. Around 1970 Japan began penetrating the US market for colour sets. When the Japanese found their products excluded from the market by several trade policy measures, other Asian countries took over. How did American firms react to this increased foreign competition?? First of all they advocated protection, but besides that, they followed "a competitive strategy centred on reducing product prices through the transfer of labour-intensive processes to low wage countries." (OECD, 1985, p.163)

What does this essentially mean?? And what does it mean for statistical tractability? Employment in the television receiver industry declined by almost 30% between 1977 and 1981. The average skill-intensity in the industry increased, as less skilled-intensive parts of the production process are relocated to low wage countries. We make an additional assumption, probably one that is not too hard to defend: we assume that the plants that are relocated to low wage countries are the relatively less R&D intensive ones.

This brief history of the television receiver industry indicates, that 4-digit level data do not guarantee that production facilities can be treated as an entity. This means that what the statistics reveal as a change in production technology might in reality be a relocation of certain parts of production capacity under pressure of foreign competition. Or stated again differently (this is an important point!) even at a 4-digit level industry characteristics might change fundamentally over time and might differ from the foreign counterparts.

Accepting the assumption of non-homogenous goods has serious implications. Rejecting trade induced explanation of observed trends on account of the "wrong" changes in factor use ratio in industries, as Krugman and Lawrence (1993), probably makes you less comfortable after this story.⁵⁵ The available direct evidence on complementarities between skill and technology/ or capital fits in this story also. The *non*-R&D (unskilled labour) intensive parts of production are relocated to low wage countries, so skill-upgrading in the developed countries and R&D activity go hand in hand.

The story above indicates that this type of outsourcing of less skilled-labour intensive parts of industries (due to non-homogeneity of production) seems relevant at a high level of disaggregation. In that case it seems that a babel like confusion, between advocates of the asymmetrical technological development and the trade based explanation, is not to be excluded.

To summarise the argument: we argue that production within a single industry cannot be viewed as one homogenous activity. Therefore outsourcing can be relevant. You can similarly argue that the level of disaggregation is insufficient to label the industry with a single production function hence that a single indicator for skill intensity is misleading.

The magnitude of outsourcing is often stated to be too small (see for example Lawrence (1994)). Usually, however, only outsourced activities of multinational firms are taken into account that are reimported again *internally* as intermediate inputs. The definition of outsourcing embraced here is more broad. Here we propose to take also "involuntary outsourcing" into account and to include imported goods sold under the brand name of a domestic firm.⁵⁶ Thus closing the doors of plants formerly producing, some now imported, "parts" of the spectrum of produced goods *within* a single industry is, similar to outsourcing.

Direct evidence

Supporting evidence for this story can be found in numerous case studies, see note (1). Cooper (1994) analyses the very unskilled-intensive (by wage profile) industries, notable textile, apparel and leather (TAL). Rising prices of the TAL goods relative to all manufactured goods are found. Can this be explained in the face of stiff competition from LDCs?? Only when you

allow for product upgrading or outsourcing. The price of imported goods might decline while the price of the slightly different domestic goods rises.

Another piece of indirect evidence can be found in the developments in the service sector of the economy (see Elfring, Van der Aa and Kloosterman, 1991). They find, for the labour market in the Netherlands between 79 and 86 a (net) shift from high and middle paying jobs in the manufacturing sector to low paying jobs in the service sector. Though indicative, we are well aware that this piece of evidence is not discriminating between the trade induced changes that we are emphasizing here and biased technological change.

Disaggregation, non-homogenous goods and outsourcing: theory and evidence

Wood (1994) spends about 500 pages on the issue of trade and wages. His focus is not on the US alone versus LDCs, but on the North versus the South. It might be for these two facts that his work is often ignored in the discussion. His comprehensive work begins with an exposition of his theoretical framework. In the Heckscher-Ohlin framework the essential (=in the long run immobile) production factors are unskilled labour and skill and knowledge attached to people. Technology is seen as prior used skill. In contrast with most other authors, Wood distinguishes three types of labour: those with no education, those with basic education, and a heterogeneous group of skilled workers. Workers without any education are assumed to be located in the South only, and irrelevant for manufacturing. So the standard Heckscher-Ohlin model is applied with two factors: workers who have basic education and those who have more skills. Basically, Wood applies the factor content of trade method. Earlier FCT calculations used the "wrong" method: they underestimate effects because inappropriate factor input coefficients are used. The coefficients should be adapted for the fact that they have changed as a consequence of the increase in competition. The most labour intensive sub-industries have long been disappeared. Part of trade is therefore now 'non-competing', in the sense that these goods are not produced in the North, as they are unprofitable by their high unskilled worker intensity. Therefore, usual calculations are strongly biased downward. This consideration is similar to the argument set forth above under the heading of *Disaggregation, non-homogenous goods and outsourcing: a new assumption*.

In the empirical part Wood takes this potential biases into account. A countervailing bias in the estimation is the result of the fact that prices of the "non-competing" goods, now produced in the South, will probably be lower. This causes an increase in demand for the good. Wood's own calculations correct for both biases and result in an estimate of a cumulative negative effect on demand for basic educated workers of about 5% of the total number of basic educated workers in the economy.

Next Wood is a bit (too?) enthusiastic when his calculations are adjusted in the following manner. Trade in services has been 'forgotten' and the effect of less skilled-intensive goods production on the skill composition of intermediate non-traded goods should also have been taken into account. Doing this yields a doubling of the estimate. Another doubling of the estimate is required to account for defensive labour-saving innovation. To be clear about the latter doubling of the estimate, trade/competition induced labour saving technology change is meant. Wood states it as follows: "Their search has been spurred by the most powerful of all instincts - the urge to survive.." (p.159).⁵⁷ In sum, a relative demand shift of 22% results for those with more skills to those with basic education. Trade matters!

There are some serious limitations to the work of Wood. It is obvious that multiplying the original estimate by four is rather arbitrary. Besides, the adjustments to the FCT approach are not very transparent nor objective and they do not meet the critics on using FCT expressed earlier.

A point raised by Baldwin (1995) is that Wood assumes similar technology, in a TFP sense, and therefore overstates considerably the number of workers with basic education, required for producing the now imported goods in the North. Lawrence (1994) is also critical. He tries to ridicule the adjustments of the coefficients proposed by Wood and states: "Suppose **all** the growth in US imports over the 1980s reflects imports of products that were **not** produced in the United States in 1980 at all. Had imports from developing countries not increased, therefore, Americans would have spent their money on **other** domestic products..... which were not unusually labour-intensive." (p.14) Clearly, Lawrence just did not get the point that the "non-competing" imports are not a static fact of the economy. To illustrate this, we reiterate Wood's

statement: "Northern firms have *ceased* to produce many manufactured items currently imported from the South."(p.73, italics added).

Feenstra and Hanson (1995) presented a stylized augmented Heckscher-Ohlin model that rigorously represents the argument set forth above. They, however, change more assumptions at one time: besides dropping the homogeneity assumption they allow for mobile capital.

Feenstra and Hanson (1995) notice the incompatibility of the relative wage trends in the US and Mexico and the observed changes in factor intensities in production in the US. Instead of concluding that asymmetric technological change is the principal cause they develop an augmented Heckscher-Ohlin model.⁵⁸ The model is the Dornbusch-Fischer-Samuelson (1978) model, amended to allow for low-skilled and high-skilled workers and capital. Final products are produced from a continuum of differentiated intermediate goods that are tradable across borders. These intermediate goods can be ordered by increasing skill intensity. The division of production of intermediate inputs over the countries in the relative high and the relative low skilled is determined by four 'endowments'. The level of technological attainment (TFP), capital endowment and of course the ratio of skilled to unskilled workers. The essential assumption is that outsourcing can be important and that imported goods from an industry are (completely) different from domestically produced ones. Hence assuming an equal production technique across countries within a sector is thought to be too restrictive.⁵⁹

In the Feenstra and Hanson model foreign direct investment (FDI) or an improvement in the technological abilities in a low skilled abundant country will increase the relative wage of skilled workers in *both* countries! This result is easily understood intuitively. The less skilled-intensive part of the whole spectrum of intermediate goods shifts from the skilled rich to the skilled poor country; relative demand for skilled workers increases in the skilled rich country. For the skilled poor country these new intermediaries are relatively skilled-intensive ones, thus also in this country the relative demand for skilled workers increases.

Part of the empirical contribution of the paper concentrates on the magnitude of foreign direct investment. Often approaches based on FDI or outsourcing are nipped in the bud by stressing that the share of imports in purchased materials is too small,⁶⁰ or that the flows of FDI are

insignificant in magnitude. Feenstra and Hanson argue that the used definitions for outsourcing are too narrow to assess the actual impact of the possibility not to produce at home. The usual definition includes only materials, parts, components and so on. One example might clarify why this definition, excluding finished products and contract work, is too small. General Electric imports now all its microwaves (from the Korean firm Samsung) and sells these under their own brand name; this is excluded by the usual definition. So Feenstra and Hanson proposed to amend the definition to include all intermediate and final goods used in production or sold under a domestic brand name. Foreign direct investment in Mexico increased between '83 and '87 by almost 1000%. Using the proposed definition, they are able to explain 25% to 33% of the wage-bill share change of non-production workers by changes in the import shares.⁶¹ In Feenstra and Hanson (1996) new data are used and up to 50% of the wage-bill share increase of non-production workers can be attributed to outsourcing.

Lawrence (1994) states: "If outsourcing is important, the decline in blue-collar intensity in the US should be associated with an increase in blue-collar intensity abroad." (p.23); the outsourcing model he has in mind is not clear, but clearly different from the Feenstra and Hanson-model. And he continues: "if global changes in technology were dominant, we should see parallel increases in the ratio of blue to white collar employment in the US and in the rest of the world and similar movements in wages." (p.23). Taking the Feenstra-Hansen model into account this is not an obvious repercussion of a global change in technology. Here we would suggest again that it might be the case that a kind of "babel like confusion" is going on between those in favour of the biased technological change explanation (that is hard to separate from trade induced outsourcing) and those favouring a significant role for trade.

A limitation to their work is that the reported regression is not an actual test for their model but only a fairly general test of the correlation between imported 'inputs' and the wage-bill share of high skilled workers.

Imperfect competition and rents: a new assumption

Perfect competition is common assumption in the models relating trade with wages. A notable exception to this extreme assumption is Borjas and Ramey (1993). They argue that competition

in parts of the economy is far from perfect and that the consequent profits are shared with workers.⁶²

Imperfect competition and rents: theory and evidence

Borjas and Ramey (1993) analyze what variables have the same long run trend as the wage inequality series from 1968 to 1988. The only variable that does a good job is the trade deficit in durable goods. R&D expenditures and de-unionisation had very different trends in earlier periods. The intuition is that durable goods industries are thought to be highly concentrated and therefore to generate high rents which are shared with their (in majority less skilled) workers. They provide a theoretical underpinning of this result. In a Cournotian two sector model, rents are dissipated in case of increased competition (proxied by an increase in the number of competing firms). The concentrated industries are relatively important employers of less skilled workers. Therefore, a relative small increase in foreign competition is likely to have a large effect on wage inequality.

The theory is tested by applying the model to different regions in the US. The magnitude of the inequality increase differs substantially between regions (a sufficient immobility of workers is implied). In a regression⁶³ the strong correlation between manufacturing employment and skill return vanishes after controlling for time and area. After disaggregating manufacturing according to concentration and vulnerability to foreign competition, a strong negative correlation, between high concentration import industries and the return to skill, is found.⁶⁴ Borjas and Ramey also pose the obvious question whether the magnitude of the estimated coefficients is large enough to explain the observed trend. Ten percent of the wage inequality change can be explained by the change in the share of employment high-concentration industries.

More factors: Capital as a relevant factor of production

Usually, the standard trade theory is presented in terms of capital and labour. Today capital does not seem to be that important any more. Even *mentioning* capital in the theoretical explanation is not necessary for Krugman and Lawrence (1993). Wood (1994) argues that capital is reproducible and tradable and states that "all theorists would agree that this type of input cannot

in itself affect the pattern of trade" (p.34). In itself the argument might be correct, but we are looking at a "kind of opening-up". Sachs and Shatz (1994) (and Feenstra and Hanson, 1995) disagree with the denial of the role for capital and suggest to add an initial lack of physical capital in the LDC to a similar framework as presented in the discussion of the Stolper-Samuelson theorem. Now two sectors are distinguished, one producing with capital and skilled workers and one with capital and unskilled workers. The LDC's lack initially capital and high skilled workers. Opening-up would yield a capital flow from the US to the low wage LDC resulting only necessarily in a relative decline in the reward of the scarce factor and increased imports of the unskilled-intensive good (thus, only the weak version of prediction (1)) and prediction (4) in section 4). This is not too hard to see. Facilitating possibilities for capital flows result in a flow from the US to the LDC. No skill intensity change is obvious from the construction of the model. Also a relative goods price change is not necessary. These issues are important, because the rejection of Heckscher-Ohlin theory (and, often, with it the relevance of trade) is based on the not coming true of one of the predictions (2)(3) and (5).

Unfortunately empirical work with Sachs and Shatz' model in mind is not available.

Many goods/sectors: specialisation?

The Stolper-Samuelson predictions in case of specialisation are not unambiguous. Though it is beyond the scope of this paper to discuss the method used by Leamer (1987) to determine the Stolper-Samuelson derivatives, it might be useful to stress the basic message. The basic message bearing on the Stolper-Samuelson theorem in a $3 \times n$ (factor \times goods) model is that the results hinge on the specialisation pattern of the country under consideration. Or, stated differently, the logic of the Stolper-Samuelson theorem ceases to be rectilinear if: "(a) some non-produced goods rise in price relative to produced goods and some fall, and/or (b) the prices of produced goods change relative to each other and relative to some non-produced goods' prices" (Ethier (1984) p.145). This need not be a theoretical exception if you keep the remarks in the section *Disaggregation, non-homogenous goods and outsourcing serious*. There we argued that certain goods within narrowly defined industries ceased to be produced. This would imply that complete specialisation within industries on slightly differentiated goods or on stages of the

production is not unlikely. Empirical work taking this modification explicitly into account is not available.

More sectors: a sheltered sector

Advanced economies usually incorporate a sector sheltered from foreign competition that amounts to at least half the economy. Taking this explicit into account, does this alter the predictions?

In theory,⁶⁵ adding a non-traded goods sector does not alter the basic results. As long as there are at least as many goods as factors produced in both countries, factor prices are derived from zero profit conditions and the price of the non-traded good adjusts correspondingly. In case of specialisation the strict logic is again broken. Leamer (1996a) discusses also these two cases. In the first case, where international prices set factor prices via zero profit conditions, the marginal demand for labour is 'external'. In case the economy specialises on one traded good and the non-traded good, the marginal demand for labour is said to be 'internal' (and thus a trade deficit matters).

This last case is probably implicit in Cooper's⁶⁶ mind while arguing: "labour is shed from the tradable sector even with flexible wages (because goods are non homogenous, specialisation is very likely).⁶⁷ The question then becomes: How good is the economic system at absorbing the released labour with little decline in wages?" This is a highly relevant question if the manufacturing size declines substantially, how much of a wage decline need workers to accept to be absorbed in the non-traded sector.

7. Remaining Issues

Our main focus is on the empirical assessment of potential explanations for the increased education premium. There are however some approaches that deserve attention anyway although the ideas offered are not yet empirically scrutinized. The remainder of this section provides an

impression of possible interesting ways to proceed (in empirical or theoretical work) in the future.

Bhagwati and Dehejia (1994) reject the Heckscher-Ohlin theory on the assumptions that are judged to be unrealistic and not met in reality. They provide alternative theories not yet empirically examined. Three new trade based theories are presented. Doubt is expressed in advance on the weight carried by these approaches in the empirical assessment.

The relation with trade, in these theories, is different from that in Heckscher-Ohlin theory. Bhagwati and Dehejia (1994) also see the highly integrated world as a potential cause for the increasing inequality that is observed. The three arguments all run from the basic premise that the increased integration of the world causes a higher volatility in the terms of trade. The first mechanism runs from higher volatility (more sudden shifts in comparative advantage on sector level) to higher labour turnover to more frictional unemployment and a flatter earnings growth curve due to less skill accumulation by learning by doing. Bhagwati *et. al.* call this the "rolling stones gather no moss" approach. If this works out asymmetric between high and low skilled workers, as higher skills are less firm specific, the increased wage differential is generated.

A second approach takes a similar starting-point (increased uncertainty) but focuses on education, *i.e.* the supply of skilled versus unskilled workers. Becoming skilled requires a sunk cost investment. Increased uncertainty makes workers less reluctant to upskill and enlarges the sustainable wage differential. We have already seen, however, that supply changes cannot tell the whole story.

Finally and more conventional, in a dual economy with only one unionised sector "good" jobs are lost, by terms of trade changes that negatively affect the competitiveness of the unionized sector. In the US the impact of competitiveness on union power is reflected in a smaller intersectoral wage differential and in Europe in a decline of the number of insiders. Bound and Johnson (1992) have already shown that this mechanism is not very relevant.

In the previous section we spend a lot of words on arguing that the assumption of identical or homogenous production functions within specific industries over time and across borders is too strong. Rosen (1981) explains increasing inequality by arguing that the assumption of

homogenous production factors within specific subcategories on the labour market is too strong.

The 'superstar' model, illustrating his argument, builds on two basic blocks, increasing returns to quality and decreasing production costs to scale. Some results: the larger the market the more important returns to scale are (Rosen connects these with increased communication and transport possibilities) and this produces more skewed income distributions. Rosen provides therefore an explanation for the increase in overall inequality. When there is some asymmetry for different skill types in this mechanism, this provides a potential explanation for the increase in the relative wage of high skilled workers. To illustrate the asymmetry we have in mind: think of a surgeon and someone doing assemblage. Assume a type A and a type B of the surgeon and the assembly worker. Surgeon⁶⁸ A gives you 10% additional chance to survive compared to B and the assemblage worker A is 10% quicker than B. You are probably willing to pay 10% more for assemblage worker A than B, but probably 50% more for surgeon A than for B??

Reich's book on *The Work of Nations* (1991) discusses growing inequality of workers with different types of jobs. Empirical work is not discussed explicitly, but as Reich seems to have strong ideas about the topic it is worth discussing part of the book.

Convincingly, Reich stresses that traditional job classification utilized by the Census Bureau is not suited for analyzing issues connected with ongoing globalisation. Argued is that the employer type is no longer relevant for analyzing future prosperity but the type of work that is performed is what matters. A new categorization is proposed: workers carrying out routine production services, in-person services and symbolic-analytic services. The routine productions workers are workers performing routinous jobs, like blue-collar workers and low and middle level managers and data processors. The in-person service workers perform also routinous jobs, but the nature of the service requires personal interaction. Symbolic-analyst perform complex jobs in solving and identifying problems. Think of researcher, certain lawyers and accountants and so on. The latter two categories of the type of workers are rising in number while the former is declining. Reich foresees a quick globalisation: "In a *very few* years, there will be virtually no way to distinguish one national economy from another.."(p. 172, italics added).

This process, directed by declining transport and communication costs is evaluated as to have inherent advantages for symbolic-analysts, as their jobs are most highly rewarded in the world. The routine production workers see their jobs relocated to Asia, Latin America and so on.⁶⁹ The in-person service workers are protected largely from global competition but they face increased competition from former routine production workers and (il)legal immigrants. Besides the indirect competition also labour saving technology is negatively affecting prosperity of in-person service workers. But in this part of the economy new jobs are generated easily.

Actually Reich tells a story (rhetorically excellent) of FPE; transport and communication are negligible factors and symbolic-analysts are relatively scarce in the world. Essentially he endorses the trade explanation.

7. General discussion

It is time to evaluate the presented evidence. The facts are indisputable. Despite increasing relative supply of skilled workers the evolution of factor rewards has been beneficial for the more skilled. Thus, somehow an explanation needs to be given for the fact that factor demand has developed in a direction favourable for skilled workers.

It might be necessary to repeat our aim. A whole palette of potential explanations for the increase in the relative wage of the high skilled is available: education, trade, immigration, deunionisation, technological change, deregulation and so on. It appears however that trade has been taken off the table as a potential explanation. We stress no more than that a significant role for trade cannot be excluded on the basis of the available evidence. Thus putting trade as an explanation back on the palette of explanations alongside others (*maybe* including unfavourable technological change) is what is done.

To corroborate this statement several arguments will be put forward. First will be stressed why we are not so eager to accept the alternative explanation for trade. Second, subsequent arguments for rejecting the role for trade are disputed.

The first reason for not being eager to accept the alternative 'technology related' explanation is the following. Above is explicitly stated that biased technological change 'maybe' is among the explanations, because the argument favouring the explanation of technological change is not available. It is just what we observe as an unexplained residual and mark as 'biased technological change'. Or like Davis and Topel⁷⁰ state: "Skill-biased technical change is largely a name for our ignorance" (p.218). But also one of the opponents to the trade explanation is critical with respect to the offered alternative, Krugman (1994b, p.148): "If trade doesn't explain the rise in inequality, we are left primarily with the all-purpose explanation known as "technology"." There is no need to push this any further. In remainder the discussion will be set forth like it is between the *opponents of the trade explanation* and *opponents of the technological change explanation*.

The second reason for being hesitant in accepting technological change as the relevant alternative, is the low discriminative power of the offered direct tests, like the ones by Bartel and Lichtenberg (1987), Mincer (1991) and Berman *et.al.*(1994). In the section on *Disaggregation*.. we argued that the significant relation between skill-upgrading and technology might equally well reflect outsourcing of low skill / low tech elements of the production process.

A third issue is the unlikeliness of the biased technological change explanation viewed in the light of the sluggish productivity increases since the early 70s. Is there a reason for weak productivity growth to be biased strongly against unskilled workers?⁷¹

The final argument in making a case against the dominance of the technology based explanation is in line with the discussion in section 5 on technology. Taken the open economy view where (induced) technological change is a local phenomenon, it is hard to make a case for the technology explanation without taking the element of foreign competition into account. Only for the case (not in line with the popular view) where high skilled workers are becoming more productive, it is thinkable that the increased wage differential induces this change. But, again, the skill intensity within industries moves in the wrong direction.

Summarizing the arguments: technological change is a residual "explanation" and what is claimed to be technological change might equally well be attributable to trade.

Next we will reconsider subsequent arguments that were brought on the scene by opponents of the relevance of the trade hypothesis.

It is argued that in the 80s the shift in factor demand was for a vast part a shift that took place within single industries, indicating that trade induced goods demand changes had not come into play (Katz and Murphy, 1992; Berman, Bound and Grilliches, 1994 for example). For two reasons this argument is not convincing. First and most important, as claimed above (see on *Disaggregation.*), the statistical classification of used data is just not suited to distinguish between and within industry shifts. Second, as stressed by Baldwin (1995) and Baldwin and Cain, the issue at hand should be analyzed in a general equilibrium framework. That learns that within and between industry shifts occur both in case of technological change-induced and trade-induced reallocation.

Furthermore there are tests related to the magnitude of international trade relations. The volume of trade, an argument used by Krugman and Lawrence (1993), is rather uninformative. As stressed by Bhagwati (1991) ex post trade volumes are not informative to assess the role for trade. If the situation on the world market changed dramatically it can be so that despite (and due to) huge internal adjustments, trade volumes have not changed. Related calculations, using the Factor Content of Trade approach, are not very informative from the perspective of the Heckscher-Ohlin model. The Stolper-Samuelson theorem connects factor prices with international price changes. Quantity changes do not enter the formulation of the theorem. The factor content of trade is determined by the equilibrium conditions for the factor markets (Leamer, 1995). Furthermore, deviations from balanced trade are also muddling up FCT calculations.

Next, there are tests that are actually clearly related to the Stolper-Samuelson theorem. For example the tests on factor intensities within industries, shifts in employment between industries and goods prices. We can summarize our arguments on the unreliability of these tests of the Stolper-Samuelson theorem as follows. First, the habit to treat industries, that are classified for statistical purposes by goods type, as an homogenous entity with single factor input requirements is obfuscating the analysis. Second, as the Stolper-Samuelson theorem is formulated with unchanged endowments it is necessary to keep in mind that this has not been the case. And the third, and most obvious, argument is related to difficulties in measurement (for example,

measuring skill). Next is explained briefly how the here summarised arguments might muddle up the detection of the Stolper-Samuelson predictions in the data.

The prediction that the skill intensity within industries *should* fall and *has been* rising is an important part of the puzzle. The logic of the Stolper-Samuelson prediction of an increase in the ratio of low to high skilled holds in the case of unchanged endowments in the 2 x 2 x 2 version of the model. Three influences changing the endowments are the fact that the overall size of the manufacturing sector shrank, that the relative supply of high skilled workers continued to increase during the 80s and that unemployment changed. We do not consider the latter issue, raised by Sachs and Shatz (1994), as it is not discussed in the literature. Hall⁷² raised the point that the continuing supply increase might muddle up the picture. That the Rybczynski theorem does learn that factor intensities are unaffected by factor endowment changes only holds for small countries. The decrease in manufacturing sector size is an issue on its own (Krugman, 1995), but again an issue that makes it troublesome to evaluate the change in skill-intensity within industries. The other argument, on the non-homogeneity of industries, implies the following. When an industry is non-homogenous with respect to the skill intensity of production, outsourcing of less skilled activities within the industry *yields* an increase in the ratio of high to low skilled workers within industries.⁷³ Altogether this is enough to raise serious doubt about the relevance of the theoretical prediction that the ratio of low to high skilled workers should increase.

One of the most reliable indicators in theory, though not indisputable, is highly unreliable in empirical work. In applying Heckscher-Ohlin theory the price level is the variable where one should direct one's measurement effort at. The price of goods that are intensive in unskilled workers should fall relative to goods that are intensive in skilled workers. Above we reported that Lawrence and Slaughter (1993) *did not* find this, and that the relative wage trends could not be attributed to the trade related price changes. Sachs and Shatz did find that, but they omitted the important (but indeed troublesome to measure) computer prices. Krueger (1997) *does* find an increase in the relative price of skilled intensive goods. Leaving the 2 x 2 x 2 Heckscher-Ohlin approach, followed in most of the work, the predictions on relative prices change. The deviating approach suggested by Sach and Shatz (1994), with (initially) immobile capital as an additional factor, where capital scarce LDC's are assumed, the prediction on prices

is not necessary for trade to play a role. The non-homogeneity within industries leads in the Feenstra and Hanson (1995) model to a 'modified Stolper-Samuelson result': for trade to play a role in increasing the wage differential the domestic price should rise more than the import price. This reflects the fact that factor intensities of inputs produced in the North are skilled intensive and those from the South skilled extensive within the same industry. Empirically this is clearly confirmed. So if you allow for somewhat deviating assumptions, like those proposed in section 6, the theoretical prediction on prices for assessing a role for trade alters.

Non-OECD evidence could have contributed to the debate, as Heckscher-Ohlin theories predict an opposite trend for factor reward in the unskilled rich countries. This contribution, however, is not very informative because: "The time-series evidence for these economies is much flimsier than is usually supposed,..." Wood (1994, p.245). The evidence presented for Mexico (and Morocco) indicates that for the countries, close to the US (and the EC), "insourcing" seems to be relevant. Evidence for these countries confirm the Feenstra and Hanson-model prediction of an increasing skill premium.

Outsourcing might be a "readily available technology". An adaptive strategy to make the business organisation more lean is to outsource. The OECD states it as follows: "United States firms have tried to improve their profitability by accelerating the transfer of their labour-intensive operations to low-wage countries. However, this strategy was clearly ineffective even in reducing the cost differential..." (OECD 1985, p, 164). What is meant is that in case of outsourcing of less skilled-intensive activities of industries this is reflected in the data as if biased technological change is going on, if the level of disaggregation is insufficient. Above is shown, by anecdotal evidence, that even at the 4 digit level this is the case.

In the field of R&D activity (technological change) and trade in relation to the adaptiveness / innovativeness of strategies, our knowledge is fairly limited. Further research in this direction is required.⁷⁴ Note that in Japan, generally recognized as a country following innovative strategies, the rise in skill premium has been very modest. This might be seen as support for the view that outsourcing is a readily available technology for firms following an adaptive strategy.

9. Summary and conclusions.

An increase in the relative wage for unskilled workers in the 80s in the US is the basic observation we tried to explain. This relatively higher reward for skilled workers is hard to explain by changes in relative supply. The increase in the supply of high skilled workers slowed down somewhat in the 80s, but the educational attainment still clearly increased. The simple reasoning that a demand increase needs to have been accompanying, or actually overwhelming, the supply increase is confirmed by several contributions in the literature.

The *obvious* explanation for changes in the relative demand for skilled workers is related to trade with low wage countries. To check the validity of this assertion several predictions of the Stolper-Samuelson theorem were empirically scrutinized. The shock that drives the results in the Stolper-Samuelson theorem, a change in the relative prices, appeared hard to detect in the data. Other derived implications, like the decrease in skill intensity within industries, moved even in the wrong direction. Disappointing results you might say. Two directions were followed after this dead-end in the basic $2 \times 2 \times 2$ Heckscher-Ohlin model.

The first direction is to point at biased technological change. The evidence that indicates that the basic Stolper-Samuelson predictions were not confirmed left several authors nothing but to point at biased technological change. This is, as stressed above, jumping to conclusions too quick! First of all, if you assume a small open economy, it is theoretically not obvious what the character of the technological change is that yields the required relative wage drop for the unskilled and the increase in skill intensity within industries. Secondly, we showed that the direct evidence favouring the biased technological change explanation is, at least, flimsy. The third reason that conclusion that 'biased technological change the principal cause for the change in the wage structure' is premature, is that it is a conclusion based on sound rejection of the other potential causes (as it is nothing more than the residual). We argued that the trade explanation is not thoroughly analyzed and is rejected on the basis of a mistrial.⁷⁵

The second approach followed is showing that the rejection of the trade based explanation is unjust. In order to do this the basic trade model is amended and/or new models are proposed. More or less similar changes to the trade model are proposed by several authors. This concerns the issue that industries on both sides of the border might differ substantially. Whether you call

it that some imports are non-competing, that the level of disaggregation is insufficient or that the importance of outsourcing of parts of the production process is underestimated does not matter. If you allow for this amendment of the trade model, predictions change and supporting evidence for a substantial role for trade is found.

Having shown that the relation between trade and factor prices is not necessarily as straightforward as the Stolper-Samuelson theorem tells and hence that the rejection of the role for trade is premature leads to the following conclusions. The central question, whether a role for trade can be ignored on the basis of the existing literature is answered negatively. Mostly likely several factors are to blame for the increase. Though debate on the weight given to those factors is still raging, some premature judgment can be made. Trade is a factor that appears important. There might be an important role for biased technological change. The role for deunionisation seems a minor one. The role for migration and changing institutional environments is still to be established.

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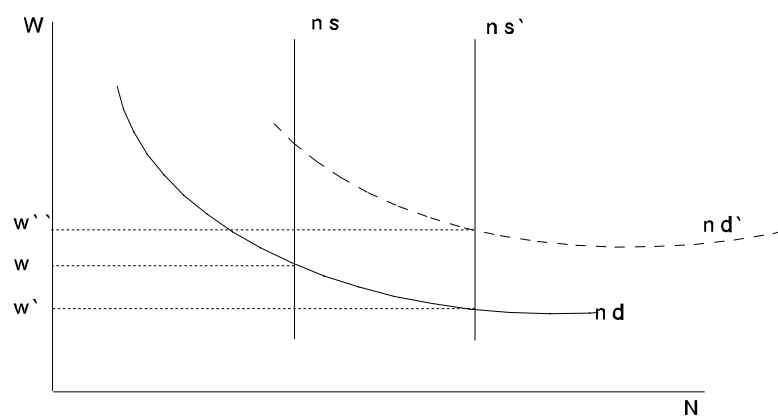
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Fig 1. Relative supply and demand.



$w = w \text{ (skilled)} / w \text{ (unskilled)}$ $N = \text{supply skilled} / \text{supply unskilled}$

Table I

Change in education wage premium in the 1970s and 1980s		
	1970s	1980s
United States	-0.08	0.09
Australia	-0.17	0.03
Canada	-0.13	0.03
Germany		0.10
Japan	-0.04	0.00
Netherlands		-0.35
Sweden	-0.09	0.03
United Kingdom	-0.06	0.08

^a Five-year average change in the ratio of earnings of college level workers to high school-level workers.
Source: OECD Employment Outlook 1993

Table II

Relative supply of college educated workers ^{ab}			
	1970	1980	1989
United States	10.8	16.6	21.5
Germany	6.0	7.4	9.4
Japan	12.0	17.9	22.5
France	5.3	8.3	11.8
United Kingdom	8.0	12.0	18.3

^a Percentages of the population.

^b For details, see Source.

Source: OECD Employment Outlook 1993

Table III
Asymmetric tech progress.

$$Q_h = a_h \left[\delta_h (b_{h,s} S_h)^{\frac{\sigma_h - 1}{\sigma_h}} + (1 - \delta_h) (b_{h,u} U_h)^{\frac{\sigma_h - 1}{\sigma_h}} \right]^{\frac{\sigma_h}{1 - \sigma_h}}$$

$$Q_l = a_l \left[\delta_l (b_{l,s} S_l)^{\frac{\sigma_l - 1}{\sigma_l}} + (1 - \delta_l) (b_{l,u} U_l)^{\frac{\sigma_l - 1}{\sigma_l}} \right]^{\frac{\sigma_l}{1 - \sigma_l}}$$

Asymmetric technological progress and the wage structure ^a						
	Equal increase ^b in b_{hu} and b_{lu}	Equal increase in b_{hs} and b_{ls}	Equal increase in b_{hu} and b_{lu} and p_f/p_h decreases	Increase $a_h > 0$	Increase $a_l > 0$	Increase $b_{hu} > b_{lu}$
Small open economy ^a	w_u/w_s increases	w_u/w_s decreases	w_u/w_s decreases	w_u/w_s decreases	w_u/w_s increases	w_u/w_s decreases if $b_{hu}/b_{lu} > (1 - \delta_h)/(1 - \delta_u)$
	S^e increases	S decreases	S increases	S decreases	S increases	S increases
	(A)	(C)	(E) ^e	(F)	(H)	(J) ^d
Closed economy	w_u/w_s increases if $\sigma > 1$ S decreases	w_u/w_s decreases if $\sigma > 1$ S increases		w^u/w^s decreases if demand elasticity > 1	w^u/w^s increases if demand elasticity > 1	
	w_u/w_s decreases if $\sigma < 1$	w_u/w_s increases if $\sigma < 1$				
	(B)	(D)		(G)	(I)	

^a We assume, of course, that technology is not globally available; in that case the open economy results replicate the closed economy results.

^b Increase means proportional increase: dx/x

^c See Sachs and Shatz (1994) and Leamer (1994)

^d See Leamer 1994

^e S indicates skill intensity

^f $\sigma_h = \sigma_l = \sigma$

1. Numbers in the introduction are taken from Lawrence and Slaughter (1993).
2. This issue will only be touched upon in section 7; it is unfortunately overlooked largely in the debate.
3. In summarising the focus is on the results, the method and data will be mentioned in passing or in footnotes, for technical details is referred to the original papers.
4. The focus is on white full-time employed men's average hourly wage rate, Current Populations Survey data for 1964-1990.
5. The strong rise in unemployment in the beginning of the eighties is thought to be a potential explanation. This hypothesis is not explored by other authors to my knowledge.
6. Picking variables that follow a similar trend as the wage differential and showing (by complex techniques) that this variable follows a similar trend as the demand shift, and that this variable thus might point at a potential explanation for the factor demand shift is what they actually do here.
7. Full time male and female wage and salary workers that worked at least one week are in the sample for 1963-1987. The method: Supply and Demand framework where each distinct category is treated as a distinct labour input with a separated (though via substitutability interacting) labour market.
8. Required is an unequal substitution elasticity between the non-labour production factor and the distinguished types of labour.
9. Assigning changes in demand caused by trade as between industry shifts is not correct from a general equilibrium perspective. See section 4 on trade theory.
10. To give some indication, Borjas and Ramey (1993), to be discussed, use time series of a cross-section of cities. Their finding is that a 10 % point increase in the foreign born population lowers the relative wage of high school drop outs to college graduates with more than 5%. They use current population survey data, so this does probably not tell much about illegal immigrants. They just measure that immigrant increase supply of less skilled workers.
11. In US it is a common notion that high-school quality deteriorated. A notion that is corroborated by the data (Bishop, 1991). Levy and Murnane (1992) argue that this cannot be an important part of the explanation, as the education premium also rose for older workers, who acquired their education much earlier. A second reason why the hypothesis is not convincing is that the hypothesis also requires that above high school education compensated for the deficiencies in secondary school, as the college graduates also passed through high school.
12. This explanation is hardly measurable, and often unmentioned.
13. Useful texts are (in order of increasing formality) Ethier (1983) Bhagwati and Srinivasan (1983) and Dixit and Norman (1980)
14. The basic $2 \times 2 \times 2$ HO model is build on the following assumptions: identical constant returns to scale production techniques, free trade, no specialisation (factor endowments are not that dissimilar such that they are outside the cone of diversification), perfect competition on all markets, factors are fixed in supply and identical homothetic preferences. A lot of these assumptions are not met in the real world. This is hardly surprising, but makes the theory not useless as a 'tool to think'. Bhagwati and Dehejia (1994) spend many pages on arguing the inadequateness of this model.
15. The logic of the Stolper-Samuelson theorem remains valid in case of monopolistic competition (see Helpman and Krugman, 1985). Ethier (1984) treats higher dimensions than 2×2 and concludes: Nevertheless it is fair to conclude that the Stolper-Samuelson theorem is not fundamentally altered by an increase in the number of goods. In case of specialisation the SS theorem does not hold in general. Komiya (1967) analyses HOS theory in case a non-traded goods sector is added. In that case it is still trustworthy to think in SS terms.
16. They restrict themselves to the manufacturing sector between 1979-89.

17. In fact the logic of the SS theorem also holds with fixed factor input ratios. Leamer (1994) stresses this but immediately admits that *if* factor substitution is feasible low skilled workers are substituted for high skilled workers. The empirically relevant case is a substitution elasticity significantly different from zero. Therefore, this theoretical argument receives no further attention.
18. In his comment on Lawrence and Slaughter (1993), Hall raised the point that the continuing supply increase might muddle up the picture. A solution to this problem is provided: consider the development of skill intensity within sectors compared to the national average.
19. This difficulty to identify skilled and unskilled workers is problematic no matter how it is approximated. This, however has to be taken for granted and will not be underlined over and over again.
20. Katz and Murphy (1992) assume trade affects production worker disproportionately. This issue will be discussed extensively in section 6. Correcting for this yields that trade is significantly affecting the unfavourable development of the demand for unskilled workers.
21. They use the Annual Survey of Manufactures from '78 to '90. They distinguish 131 industries and 150 trading partners. Again, skill intensity is represented by using production and non-production workers.
22. Deardorff and Hakura (1994) state that this indecisiveness of Murphy and Welch confuses them; Murphy and Welch show that trade is a significant determinant of changes in wages so the unexplained part must be something else.
23. See also Bhagwati and Dehejia (1994).
24. The issue, raised also by Bhagwati and Dehejia (1994), that it is highly problematic to calculate the FCT in case of serious trade imbalances is not disputed; this makes it troublesome to use the FCT approach for the 80s anyhow.
25. See section *The relative price of the unskilled intensive good declines*.
26. Deardorf and Hakura (1994) is an excellent reference to formulate the right questions.
27. Ignoring Krugman's (1995) critique, reported on in the previous section.
28. See further p. 36 and on of their paper.
29. Usual practice is to account for the globalisation effect and attribute everything else to technology, Leamer takes the mirror image.
30. Several sources are used, see table 1 in the paper.
31. To overcome the idea that Mexico might be very special due to location and their taking part in the NAFTA we refer to Currie and Harrison (1994) who find very similar pattern in Morocco after abolishing several trade restrictions. Cited via Harrison and Revenga (1995).
32. One change that might be messing up the 'laboratory experiment' is the relaxation of minimum wage policy (since 1983). This might be relevant for relative wages. Bell (1994), however, analyzed micro-data to measure compliance of minimum wages. The minimum wage though was a constraint for only 2% of the plants. The minimum wage policy is therefore further ignored. Hanson and Harrison (1995) document the considerable lowering of import licence requirements and tariffs besides the freeing of export possibilities (and a devaluation of the nominal exchange rate)
33. Mexico's exports (in value) of industry products (in 1985) was directed towards the US for over 90% (in 1992 almost 80%). For imports the number for '85 is 76% and for 1992 is 65% (Source, Wildcat datasystem, CPB).
34. Like assuming that Mexico relative skilled labour abundant to the rest of the world (but trade with the rest of the world is only a minor part of Mexican trade.

35. It has to be stressed that this is not an explicit modelling exercise. This implies that the conclusions presented in the table are not very general; perverse preferences may alter the results in the closed economy for example. Van de Klundert (1962) (in Dutch, reprinted in 1997) or Jones (1965) provides an excellent framework for analyzing changes in technology in a simple general equilibrium model. A second remark to the exercise is that we assume, of course, that technology is not globally available; in that case the open economy results replicate the closed economy results.
36. See Sachs and Shatz (1994) for a informal explanation and Leamer (1994) for a formal exposition.
37. This case might be relevant in a different context, when we take the non-tradable service sector into account. The productivity growth in the US service sector has been absolutely and relatively sluggish (Lawrence and Slaughter, 1993). The service sector is relatively high skilled intensive. The explanation for the secular downward trend in the size of the manufacturing sector is the fast productivity growth in the manufacturing sector. For this explanation to be consistent it is necessary to have an elasticity of substitution smaller than one between both aggregate sectors. This elasticity together with the notion on sluggish service productivity leads to increased inequality.
38. The question on the cause of the initial change in relative wages is of course highly relevant. If we do not explain this, the second line of reasoning is circular.
39. The consistency of these stories should of course be checked in formalising the arguments.
40. Davis and Topel (1993) provide a nice analogy with respect to the need for more direct evidence. Assuming that biased technological change is causing the increased inequality is like inferring the existence of Pluto because Neptune's orbit does otherwise not fit in the theory. The existence of Pluto is much more compelling ever since it was actually sighted in a telescope. Thus an apparatus to actually trace the bias in technology is needed for the argument to be convincing.
41. Like adding occupational dummies and checking for the influence of firm size. To control for the possibility that the computer dummy accidentally catches the fact that workers might be able to capture rents, separate regressions are run for union and non-union workers. Surprising (and yet unexplained) is the result that the return to computer use for unionised workers only about one third of that for non-unionised.
42. There is serious reason for suspicion, as it is the use of E-mail appears most productive.
43. The data on white males from one Current Population Survey in each year from 1963 to 1987 are used.
44. International competition, proxied by the ratio of net export to GNP, is however significantly negative; the right direction for a trade induced explanation.
45. Their research relies on data from the Annual Survey of Manufacturers from 1959 to 1989. The data are from producers, therefore all inputs used in production are available. Data are disaggregated at the 4-digit level.
46. For example, the between industry shifts in employment are decomposed in shifts due to more or less net exports, more or less employment occupied for defense build-up and the employment active to produce for domestic consumption. The employment is approximated by output data. The assumption that the value of output is proportional to employment is not without problems of course.
47. They decompose this in plant size and equipment; the actual complementarity is between equipment and skill.
48. Besides pointing at misuse of trade theory (see earlier in this section), doubt is expressed on the accuracy of production and non-production workers as a representation of the different skill levels. Leamer is not the only author expressing his concern on the appropriateness of identifying blue collar and production workers with unskilled.
49. The data, that Leamer criticized, from Lawrence and Slaughter are used in some (preliminary) regressions, estimating the impact of technological change (affecting low skilled workers only) on wages, leaving prices constant.
50. A regression is ran with the relative goods price change as the dependent variable and factor shares are independent variables. Industries are the units of observation. The estimated coefficients are relative factor price changes (this relation is easily derived from zero profit conditions (mobility of factors across industries and CRS technology is assumed)). Combin-

ing these estimates with actual observations on endowments, output, relative and absolute wages and the skill intensity of production they can exclude certain explanations as being dominant.

51. Population Survey data for 1973-47, 1979 and 1988 are divided in 32 sub-samples by education (4), experience (4) and sex (2). For each sub-period they estimate an extended wage equation and calculate from the coefficients the real wage for all (32) cells. In proceeding like this they filter out well known differentials caused by race, industry and region.

52. They assume full employment despite that they have chosen to leave certain types of workers out of the sample. They assume constant and equal elasticity of factor substitution between all workers and all industries. So, it is as easy to substitute for a college graduated manager with 30 years of experience, a similar employee with 25 years of experience, as a high school drop out with no experience. Elaborating further that this is a strong assumption is probably not necessary.

53. The idea is not new, and can be found in discussions on the relevance of models for intra-industry trade. See for example Finger (1976).

54. This example is taken from the "Costs and Benefits of Protection"-study by the OECD (1985), where is referred to for more examples.

55. For the story to fit the facts, one should remind the declining manufacturing sector employment. It is necessary, or at least plausible, that the trends in this story are accompanied by an on average shrinking manufacturing sector. Besides that, the increased skill intensity in manufacturing has to be met with a response somewhere else in the economy, as it is not solely supply driven. Somewhere the low skilled should be absorbed. Either the composition of the group of unemployed should become more unskilled, or the sheltered sector should show an opposite skill intensity development. The minimum requirement for this story not to be rejected is that the skill intensity of the sheltered sector is increasing less than the one in the exposed part of the economy, as the relative supply increase of skilled workers has to be taken into account.

56. Feenstra and Hanson (1995,1996) propose this latter extension.

57. Sachs and Shatz test for this assertion and find indeed a higher TFP growth in low-skilled intensive industries and would "add another few percentage points to the overall negative effects of trade on employment" (p.33). But they are unsure whether this is caused by increased import competition.

58. Markusen and Venables (1995) build a model with similar features, but a less transparent and more ad hoc specified one. The model is driven by endogenous location decisions and the possibility of outsourcing multinationals. Their model is also able, if FDI is allowed for, to generate similar results for relative wages as the Feenstra Hanson model.

59. To get some feeling for this deviating modelling approach it is useful to reiterate some crucial equations: production of the final good is modelled as costless assembly of foreign and domestic intermediates, according to a Cobb-Douglas production function:

$$\ln Y = \int_0^1 \alpha(z) \ln x(z) dz \quad \text{with} \quad \int_0^1 \alpha(z) dz = 1$$

and intermediate inputs are produced (domestically or abroad) by:

$$x(z) = A_i \left[\min \left(\frac{L(z)}{a_L(z)}, \frac{H(z)}{a_H(z)} \right) \right]^\psi [K(z)]^{1-\psi}$$

where $z \in [0,1]$.

60. See Lawrence (1994).

61. The average skill intensity over plants in Mexico remained almost constant and the variance of the skill intensity increased. This is exactly what the model predicts, see Feenstra and Hanson (1995). Feenstra and Hansen (1995) also derive

a 'modified Stolper-Samuelson result'; for trade to play a role in increasing the wage differential the domestic price should rise more than the import price. Empirically this is clearly confirmed.

62. Bound and Johnson (1992) also consider industry-rents shared with workers. They, however, apply a closed economy framework and judge the evaporation of rents as caused by de-unionisation (*i.e.* a trade independent explanation).

63. A Mincerian equation is estimated using CPS data for 1976 to 1990 divided over 44 metropolitan areas. From this standardised skill differential are obtained. These are regressed on industrial composition (the manufacturing employment share), a vectors of area and period fixed effects, the rates of unemployment and foreign born workers in the population and female participation rates.

64. These highly concentrated (import) industries, like primary metals, construction equipment, office equipment, aircraft and parts and so on, were in 1976 the important employers of less educated workers. This percentage showed a steep decline alongside their wages to 1990.

65. See for example Komyia (1967).

66. In a comment on Krugman (1995a).

67. Remark in brackets is also from Cooper but added in this quote.

68. Think of lawyers and accountants if you wish.

69. There is more to tell about the worsening prospects for this type of workers in relation to globalisation. When globalisation had not proceeded this far several circumstance were such that routine production workers would have got a bigger piece of the cake. Competition would have been less fierce and this would still allow firms to pay high wages to generate high purchasing power for their own products and to balance the interests of the corporation stakeholders (*i.e.* to pay higher wages). The high volume production organisation, still viable in times with less foreign competition, was very vulnerable to strikes and therefore tolerated workers to demand a big piece of the cake.

70. In a comment on Lawrence and Slaughter (1993).

71. Krugman (1995b) tests whether the technological explanation is internally consistent given the total factor productivity over the last 20 years. Concluded is that the technological explanation is feasible.

72. In his comment on Lawrence and Slaughter (1993). A solution to this problem is offered: consider the development of skill intensity within sectors compared to the national average (This should fall in case the SS effect was dominant).

73. See for this the Feenstra Hanson model. What we actually stress is that this model fits better with the current statistical classification.

74. One paper touches on the issues of firm strategies and wages and provide some references to case study literature that might lead the way, see Levy and Murnane (1992), section VI D.

75. Leamer (1996a) introduced this 'terminology'.